

Claim 50, line 2, delete "when disposed".

Claim 51, line 2, delete "when disposed".

Claim 52, line 2, delete "when disposed".

Add the following new claim 53:

--53. The apparatus of claim 26, wherein said rings in said tip portion are angled with respect to the longitudinal axis of the probe.--

#### REMARKS

The Examiner has allowed claims 11-15, 17-19 and 22-25. Claim 53 has been added. Claims 2- 5 and 8-10 have been cancelled without prejudice. Claim 35 was indicated to contain allowable subject matter and has now been rewritten in independent form. Claim 35 should now be allowed as well. Claims 43-52 have been revised to avoid the 35 U.S.C. § 112, paragraph 2 rejection. Claims 1, 6, 7, 11-15, 17-19, 22-26 and 33-53 are in the application.

Referring to the various portions of the outstanding Office Action in order, in the second paragraph, the Examiner has rejected claim 26 under 35 U.S.C. § 112, paragraph 2. In partic-

ular, the Examiner rejected claim 26 for failing to point out "what, if any, claimed structure allows surface phenomena of the material to be excluded, ..." and for lack of clarity due to the use of the word "may". Claim 26 has been amended to remove the language to which the Examiner objected and, accordingly, the rejection under 35 U.S.C. § 112, paragraph 2 in this respect is believed overcome.

In the third paragraph of the Office Action, the Examiner also rejected claim 43 as well as dependent claims 44-52, under 35 U.S.C. § 112, paragraph 2 as being indefinite. However, the Examiner indicated in paragraph 15 that if claim 43 were rewritten to overcome the rejections under 35 U.S.C. § 112, this claim and the claims dependent therefrom would be allowable. In particular, the Examiner indicated that claim 43 "... does not define any means or the like to actually place the instrument at different distances from [sic] the sample, and it is not clear whether the claim is, or is intended to be, so limited." Inasmuch as applicant's claimed apparatus may be positioned manually as well as mechanically, claim 43 should not be limited to mechanical positioning. To more particularly define his invention, applicant has amended claim 43 to claim "optical means, at a first predetermined distance from the surface of the material, for defining on said material at least one illumination surface area and at least one detection surface area which are separated, said surface areas on said material defining at least one path

through an interior portion of said material for performing interactance measurements ..., and, at a second predetermined distance relative to the surface of said material, for defining illumination and detection surface areas on said material which are at least partially superimposed thereby defining a surface area on said material for performing diffuse reflectance measurements;". This is proper "means plus function" language which provides the required structure to distinguish over the prior art. Accordingly, it is submitted that claim 43, as now amended, along with amended dependent claims 44-52, particularly define applicant's invention in a distinct and definite manner so as to meet the requirements of the second paragraph of 35 U.S.C. § 112 and are allowable.

In the sixth paragraph of the Office Action, the Examiner rejected claims 1 and 7, and dependent claims 2, 8, 39 and 40, under 35 U.S.C. § 102(b) as being anticipated by Borsboom (US Patent 4,884,891). To more particularly distinguish over Borsboom, claim 1 has been amended to recite "defining each of said paths by corresponding and separated surface areas on said material, one of said surface areas for passing illumination into said material and the second of said surface areas for passing transmitted illumination from said material for detection,...". Also, claim 7 has been amended to more particularly recite "aperture means for defining corresponding and separated surface areas on said material for defining each of a

plurality of transmission paths through an interior portion of said material, one of said surface areas for passing illumination into said material and the second of said surface areas for passing transmitted illumination from said material for detection,..." Applicant submits that such recital clearly distinguishes his invention over the disclosure of Borsboom.

Borsboom teaches (column 2, lines 47-54) that "the illuminating fibre may be connected to a first part of the light detection means, comprising means for measuring light back-scattered by the material being investigated and entering within the angle of acceptance of the illuminating fibre. Specifically, the sensor head may mount a single solid optical illuminating fibre having a diameter of D..." In Borsboom's figure 1, it is clear that illumination passes into the material through a surface area defined by the end aperture (diameter D) of the central fibre and is collected from the material through the identical surface area into the same end aperture (diameter D) of the central fibre. Therefore, in the case of the path defined by Borsboom's central fibre, the corresponding illumination and detection surface areas on the material are not separated, as is required by applicant's amended claims 1 and 7. The Examiner's statement that "the illuminating area (3) and the two receiver areas are distinct;..." does not reflect applicant's intended meaning in that the illuminating area and receiver area on the material for the path the Examiner identified as 3-4 are superim-

posed. Applicant has therefore amended claims 1 and 7 to more particularly define his invention.

Borsboom also teaches (column 2, lines 37-40) that the "...light collected by the illuminating fibre will have covered a short path in the material being investigated, and be hardly, if at all, absorbed." Applicant's claims 1 and 7 define a method and apparatus for "interactance measurements" which specifically involve absorption within an interior portion of the material and exclusion of any energy caused by back-scatter or reflection from the illuminated surface of the material as taught on page 2, line 28 through page 3, line 14 of applicant's specification (cf. Norris et al. Am. Journ. Clin. Nutrition, Vol. 40, 1123-1130 (1984)). This is contrary to Borsboom's teaching and is consequently patentable thereover.

Based on the above, the Examiner's objections stated in paragraph 6 of the Office Action to claims 1 and 7 and dependent claims 2, 8, 39 and 40 are believed to be overcome.

In paragraph 7 of the Office Action, the Examiner also rejected independent claims 1 and 7, together with dependent claims 2, 6, 8, 33 and 36-39 under 35 U.S.C. § 103 as being unpatentable over Howarth (US Patent 3,994,602). Claims 6, 33 and 36 have been amended to put them in independent form. Claims 2 and 8 have been cancelled without prejudice. Claims 37-39 have been amended to be dependent on claims 7 or 36.

The Examiner has relied upon Figure 7 of Howarth as "providing illumination by way of a plurality (two) different substantially parallel paths through an interior portion of a specimen (16) ...". Also, the Examiner has stated that "Each of the paths is defined by two distinct surface areas...", and that the window closer to the source "is contained within the boundary defined by the windows of the other path." Applicant submits that his invention, as now claimed, is patentably distinguished over Howarth within the intent of 35 U.S.C. § 103.

First, it should be noted that the paths of Howarth have been observed by the Examiner to be parallel; applicant's apparatus and method provide primarily non-parallel paths due to the geometry of applicant's extended surface areas. Parent claim 1, along with independent claims 6, 33 and 36, as now presented, now recites that each of the paths is defined by corresponding and separate surface areas on the material, "at least one of said surface areas of each of said paths being extended in length at substantially constant spacing from the other surface of said each of said paths, the total length of said extended surface area of said each of said paths being substantially greater than the mean distance separating said corresponding and separated surface areas defining said each of said paths". There is equivalent language in claim 7.

The total length being substantially greater than the mean distance separating the surface areas is based on

applicant's Figs. 1 and 2 and the dimensions given on page 6, lines 14-20. It is evident that the length of the ring shaped extended apertures described is approximately  $\pi$  times the mean ring diameter, or at least two  $\pi$  times the mean spacing to the other aperture defining a given path.

There is no teaching or suggestion in Howarth that any surface area be extended in length at constant spacing from the other surface area defining a given measurement path.

Also, amended claims 33 and 36 further recite that the extended surface area of one path "being substantially surrounded by the extended surface area of said another of said paths", which further distinguishes applicant's invention over the showing of Howarth.

The Examiner recognizes that "Howarth does not discuss the shape of the windows 61, 62" but states that "It would have been obvious to make these windows extended in length at substantially constant distance from the light source window because making the windows large would allow the collection of more light that has passed through the sample,..."

Applicant submits that significantly extending the windows of Howarth's invention is not obvious in view of the following.

First, Howarth's structure uses a single source window and multiple windows 61 and 62 mounted in the side of a pipe. Howarth (column 5, lines 47-52) particularly teaches that "in

many instances the mounting of the gauge of the present invention on a pipeline carrying pulp in the mechanical configuration as illustrated in Figs. 1 and 4 may be relatively difficult. This is especially true when the pipe diameter is either relatively small or relatively large;..." This difficulty is compounded by the requirement for two detection windows in Howarth's Fig. 7. Howarth teaches that the spacing between the source and detection windows is established by the characteristics of the material being measured. Because the spacing is fixed, substantially increasing the length of the window would significantly increase its size. In Howarth's case using two detection windows, the spacing is defined in Fig. 6 as  $1\frac{1}{3}$ ". Therefore, to be a constant spacing from the source, window 62 would have to be a segment of a 6" diameter ring and window 61 would have to be a segment of a 2" diameter ring.

Applicant submits that extending the length of these windows to be substantially greater than their distance to the source is contrary to the teaching of Howarth as it would further complicate the mounting as the size of the gauge would have to be increased in the direction of the pipe diameter to accommodate the lengthened window.

Second, Howarth teaches the use of translucent source and detection windows to provide "full diffusion of the source radiation into the material" and "a solid half angle of reradiation so that the detectors which are angled through holes

51 and 52 are fully sensitive to such reradiation". Such diffusion is known to result in the loss of light transmission due to back-scattering and the spreading of the transmitted light due to forward scattering. Howarth accepts such loss of light in stating (column 2, lines 55-58), "This use of diffusing windows further reduces the effect of pulp noise (short term variations in consistency due to its flocculent nature)". This is contrary to applicant's teaching that increasing the measurement volume by using at least one extended surface area for defining each path reduces the interfering effects due to a nonhomogeneous or layered distribution of specimen characteristics. The increased light transmission from the source to the detector that results from use of an extended surface area allows the spacing, and therefore, the measurement volume, to be maximized, further reducing these interfering effects. This reduction of interfering effects, rather than increasing the light collected from the sample, is a direct result of extended surface areas.

Third, as shown in Figs. 3, 4 and 5, Howarth's detectors 21 and 22 must be separated and angled so that both detectors are able to receive the same optical information from the detection window. It is evident that Howarth's dual detector arrangement would not be compatible with or otherwise accommodate a detection window "substantially extended in length", let alone a window substantially surrounding another extended window, as in applicant's claims 33 and 36.

Thus, it is submitted that the method and apparatus of applicant's invention, as now claimed, are neither taught nor suggested in Howarth and, notwithstanding the Examiner's reconstruction, are not obvious based on Howarth's teaching.

To more particularly set forth applicant's invention, claim 1 has been amended to further specify "the length of said extended surface area of said each of said paths being substantially greater than the distance separating said two distinct and separate surface areas defining said each of said paths". Claim 7, directed to the apparatus, has been correspondingly amended.

Claim 33, previously appended to claim 1, is presented in independent form and incorporates the subject matter of the amended claim 1. Claim 33 in part recites "an extended surface area of at least one of said paths being distinct and contained within the boundary defined by an extended surface area of another of said paths and being substantially surrounded by the extended surface area of said another of said paths;". Claim 36, previously dependent upon claim 7, is presented in independent form and has been correspondingly amended.

In the seventh paragraph of the Office Action, the Examiner has commented that Fig. 4 of Howarth, "shows an angle between the illumination axis (through window 17) and the detector axis (through window 18)." Applicant assumes such comment pertains particularly to claim 6 which is directed to applicant's feature of illuminating the surface of the material being mea-

sured at an angle. Claim 6 is now presented in independent form to include the subject matter of claim 1. Claim 6 particularly recites "directing the illumination at the surface of the material at an angle with respect to the illuminated surface of said material and generally in the direction towards the respective detection surface area on said material". Howarth shows detectors mounted at an angle, not applicant's feature of directing the illumination at an angle.

Howarth (column 2, lines 49-55) teaches "The windows 17 and 18 are preferably of translucent quartz to provide in the case of transmission window 17, full diffusion of the source radiation into material 16 as is shown at 19 and in the case of the receive window 28, a solid half-angle of received radiation which is detected by a sample radiation detector 21 and a reference radiation detector 22".

"Full diffusion of the source radiation" intends distribution of the energy over the complete solid half angle by window 17, thereby removing any directionality that may have existed prior to the illumination reaching the window. Certainly, significant energy is directed away rather than "generally towards the respective detection surface area on said material", as recited by applicant. This is directly contrary to applicant's teaching (page 8, lines 7-10) that "For interactance measurements on specimens which have limited backscatter,

introduction of the energy at an angle directed toward the detector improves the efficiency".

Similarly, Howarth's translucent receive window 18 destroys the directionality of the radiation leaving the detection surface area of his structure. Therefore, Howarth's mounting of the detectors at an angle does not result in any increase in energy collection and is not in any way equivalent to or suggestive of applicant's invention. While it may be obvious to incorporate Howarth's embodiment of Fig. 4 in his Fig. 7, this embodiment does not suggest or teach applicant's invention.

Dependent claims 37-39 have been amended as to their respective parent claims and therefore are now dependent on claims 7 or 36. It is submitted that the invention presently set forth in claims 1, 7, 33 and 36 does indeed distinguish over Howarth as well as Borsboom for the reasons stated above. Similarly, those claims depending on these independent claims also patentably distinguish thereover.

In the eighth paragraph of the Office Action, the Examiner has rejected dependent claims 3, 5, 9, 10 and 41 under 35 U.S.C. § 103 as being unpatentable over Howarth or Borsboom in view of Venable (U.S. Patent 4,711,580) and Lebling (U.S. Patent 4,583,858). Claims 3, 5, 9 and 10 have been cancelled without prejudice. Although the Examiner has indicated that both Howarth and Borsboom show "the basic claimed arrangement" of applicant's invention, applicant has hereinabove distinguished independent

claims 7 and 36 and parent claim 39 over both Howarth and Borsboom and submits that claim 41 should be allowed.

The Examiner has stated in his paragraph 8 that "It is known in general in the art that light paths can be reversed and a light source and a plurality of detectors can be replaced by an equivalent arrangement of a detector and plurality of light sources". Applicant agrees that this is correct in many situations. However, the measurement performance of these two arrangements is generally not equivalent due to practical considerations of the entendu, or optical throughput, of the various components and the relationships between the size of components and their signal and noise characteristics. Assuming that the numerical aperture of the source and detector and all other factors are held constant, the detected signal is proportional to the product of the illumination surface area,  $A_i$ , and the detection surface area,  $A_d$ . This situation results from the effects of scattering between these surface areas. For most types of detectors, the detector noise is proportional to the square root of the detector area. Therefore, the detector limited signal to noise ratio obtainable in interdistance measurements is proportional to  $A_i \sqrt{A_d}$ . It is clear that interchanging the illumination and detector areas in the cases considered here does not produce equivalent performance.

Claim 41, together with its parent claims 7, 36 and 39, defines a central detection area surrounded with the extended

illumination surface areas, which provides a relatively small detection area which allows user of smaller and, therefore, more sensitive, detectors than would be needed for an extended detection surface area. The extended illumination surface areas also allow use of larger and, therefore, more intense, light sources, thereby providing additional light energy into the material. This embodiment, which is particularly useful with detection systems requiring small input areas such as a diode-array spectrometer, is contrary to the Examiner's suggestion that it would be obvious that making Howarth's detection "...windows large would allow collection of more light that has passed through the sample...".

Nowhere does Howarth suggest or teach the use of a single detection window with multiple extended illumination windows.

In the ninth paragraph of the Office Action, the Examiner rejected dependent claim 4 under 35 U.S.C. § 103 as being unpatentable over Howarth or Borsboom in view of Venable and Lebling et al as applied to claim 2 above, and further in view of Badessa (U.S. Patent 3,733,137). Claim 4 has been cancelled without prejudice as being unnecessary in view of the independent claims.

In the tenth paragraph of the Office Action, the Examiner rejected claims 34 and 42 under 35 U.S.C. § 103 as being unpatentable over Howarth or Borsboom as applied to claims 1 and

39 above, and further in view of Hirao et al. Claims 34 and 42 are dependent claims which are rendered patentable based on the patentability of their respective parent claims in that neither Borsboom nor Howarth render the parent claims unpatentable.

In the eleventh paragraph of the Office Action, the Examiner also rejected claim 26 under 35 U.S.C. § 103 as being unpatentable over Venable (U.S. Patent 4,711,580 and Gerber (U.S. Patent 5,003,500) in view of Lebling et al (U.S. Patent 4,583,858). Venable, the principal reference here, shows a plurality of individual fiber optic elements called viewers (103) for receiving light from a sample. Viewers are mounted so as to collect reflected light at three different angles relative to the normal to the surface but all the viewers view the same sample surface area as is illuminated by the source 102. Gerber also clearly shows and teaches use of a single ring of fiber optics for collecting reflected light from the illuminated surface area. Lebling reverses the direction of optical propagation so as to use a plurality of illuminating fiber optics and a single fiber optic for collecting reflected energy from the illuminated surface.

"Interactance" and "transmittance" measurements, the only functions claimed by applicant, both, by definition, require separate illumination and detection surface areas. The construction of Venable, Gerber and Lebling are clearly performing

reflectance measurements and there is no teaching of the use of any of these constructions for interactance or transmittance.

The references fail to teach the use of rings "for receiving optical information from within a particular material ... for developing an independent signal corresponding to an illumination signal corresponding to an illumination path through said material", as is now claimed by applicant. Applicant submits that claim 26 is clearly patentable over this combination of references.

New claim 53, dependent upon claim 26, adds the further feature requiring that the rings in the tip portion are angled with respect to the longitudinal axis of the probe. This feature is also not shown or suggested by the cited references and provides a further basis for distinguishing over the references.

In the twelfth paragraph of the Office Action, the Examiner rejected claims 43 and 52 under 35 U.S.C. § 102(b) as being anticipated by Witte (U.S. Patent 4,054,391). Following the Examiner's suggestion in paragraph 15 of the Office Action, claim 43 has been amended to include the subject matter of amended claim 35, which now clearly distinguishes it from Witte. Also, the configuration of Witte is arranged to measure specular reflection rather than applicant's measurement of interactance at a first distance and diffuse reflection at a second distance. The amendment to claim 43 includes this distinction. Therefore,

the rejection over Witte set forth in paragraph 12 no longer applies.

In the thirteenth paragraph of the Office Action, the Examiner rejected claims 44, 48 and 50 under 35 U.S.C. § 103 as being unpatentable over Witte. This rejection no longer applies due to applicant's amendment to the parent claim 43.

In the fifteenth paragraph of the Office Action, the Examiner objected to claim 35 as being dependent on an unallowable claim but the Examiner remarked that it "apparently contains allowable subject matter". Claim 35 has been rewritten in independent form to include the limitations of its parent claim 1, as previously presented. An allowance thereof is respectfully requested.

The Examiner's remarks in paragraph 16 of the Office Action concerning distinct illumination and detection areas has been noted. Applicant agrees with respect to Howarth and Hirao et al, however Borsboom's use of the central aperture for both illumination and detection is contrary to applicant's intended usage of the word "distinct". As discussed above, applicant has amended the appropriate claims to clarify that meaning.

In view of the above, it is submitted that all of the issues in this case are now resolved and that those claims not

previously allowed have been shown to be in proper form and allowable over the cited art. If this Amendment is not entered for purposes of allowance, please enter it for purposes of appeal. The Examiner is encouraged to contact the undersigned by telephone should there remain any issues which may be disposed of by further discussions.

Respectfully submitted,

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